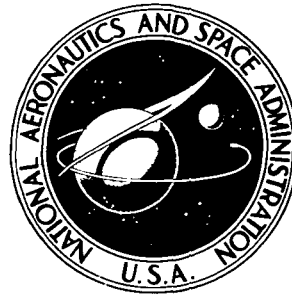


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**ION PLATING
WITH AN INDUCTION
HEATING SOURCE**

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16. Abstract <p>Induction heating is introduced as an evaporation heat source in ion plating. A bare induction coil without shielding can be directly used in the glow discharge region with no arcing. The only requirement is to utilize an rf inductive generator with low operating frequency of 75 kHz. Mechanical simplicity of the ion plating apparatus and ease of operation is a great asset for industrial applications. Practically any metal such as nickel, iron, and the high temperature refractories can be evaporated and ion plated.</p>			
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ION PLATING WITH AN INDUCTION HEATING SOURCE

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SUMMARY

An evaporation source which is heated by induction heating is introduced in ion plating. A bare induction coil without shielding can be directly used in the glow discharge region with no arcing. The only requirement is to utilize an rf induction generator with low operating frequency of 75 kilohertz. Evaporation with induction heating in ion plating presents a simple apparatus configuration which can be conveniently utilized for industrial applications.

INTRODUCTION

Because of its simplicity and convenience, the vapor heating source most commonly used in ion plating is a resistance heater, utilizing a refractory metal boat or filament. However, this technique has disadvantages. It cannot be used, for metals which in their molten state react with the boat, and for evaporating high temperature metals such as the refractories. To circumvent these shortcomings other evaporation sources have been incorporated in ion plating and in many instances have been quite successful.

Electron beam melting has filled many of the gaps which could not be performed by resistance heating. The only drawback with electron beam melting is that it cannot be utilized on a larger commercial scale in ion plating, because of the complicated operational conditions required. Electron beam guns are high vacuum devices and should not be utilized directly at the pressures where glow discharge exists during ion plating. To prevent this from occurring, the gun is isolated from the plasma and is differentially pumped. Other sources which have been tried on a more limited scale are arc discharges and sputtering targets. Each of these techniques has its advantages and disadvantages which essentially depend on the particular application.

The objective of this report is to introduce an old and relatively simple method - induction heating - as an evaporation heat source under glow discharge conditions. The simplicity of this method is that a bare induction coil without shielding can be directly

used in the glow discharge region with no arcing.

Metals which because of their reactivity or high melting temperature could not be evaporated by resistance heating can easily and quickly be evaporated by induction heating. The unique characteristics of the ion plating are retained in terms of the throwing power and the penetration or alloying effects which are responsible for strong adherence.

APPARATUS

The ion plating by induction heating (IPIH) apparatus is shown photographically and schematically in figure 1. It consists essentially of the specimen (cathode) to be coated and the evaporation heating source which is a ceramic crucible with the metal inductively heated. The specimen is an internal part of the high voltage ceramic-metal vacuum feedthrough and is connected to the negative terminal of the high voltage power supply. The positive terminal of the high voltage power supply is grounded.

The plating conditions used were those most commonly utilized in industrial ion plating (negative potential 3 to 5 kV, argon pressure 15 to 20 μ m, and the current density 0.3 to 0.8 mA/cm²). The conventional rf induction generator with a frequency of 450 kilohertz cannot be utilized in ion plating since severe arcing of the coil takes place in the glow discharge. To overcome this difficulty, the operating frequency is reduced to about 75 kilohertz.

Referring to figure 1, the power to the induction coil is supplied by means of a coaxial feedthrough. A 5-kilowatt induction generator with a (20-to-1 ratio) load-coil transformer in the output circuit supplies power through the coaxial feedthrough to a four-turn induction coil which accommodates a 2.5-centimeter-diameter ceramic crucible. With an operating frequency of 75 kilohertz the voltage across the coil is 70 volts. At this frequency the induction coil does not require external shielding and a bare copper coil is used.

RESULTS AND DISCUSSION

A number of metals, which were practically impossible to deposit by resistance heating evaporation due to severe alloying with the refractory boat, can now be effectively evaporated and deposited by induction heating in any desired thickness. Metals, such as nickel, platinum and iron were deposited up to thicknesses of 50 micrometers (2 mils), with the same strong adherences normally obtained in ion plating. High-temperature melting metals such as the refractories can also be evaporated by induction heating, utilizing an appropriate induction generator.

Evaporation by induction heating in ion plating has an additional feature which re-

sistance and electron beam methods do not possess. It produces a significant degree of ionization of the evaporant metal. This additional amount of ionization of the metal evaporant is of the greatest importance in ion plating.

Evaporation by induction heating in ion plating presents a simple apparatus configuration which can be conveniently utilized for industrial applications. The low operating frequency of 75 kilohertz is the basic requirement for operating a bare induction coil in a glow discharge region.

CONCLUDING REMARKS

A new evaporation source, induction heating, is introduced in ion plating. A bare induction coil can be utilized in the glow discharge to evaporate metals which cannot be evaporated by resistance heating. Mechanical simplicity of the ion plating apparatus is of great importance for industrial applications and induction heating provides this feature.

Lewis Research Center,
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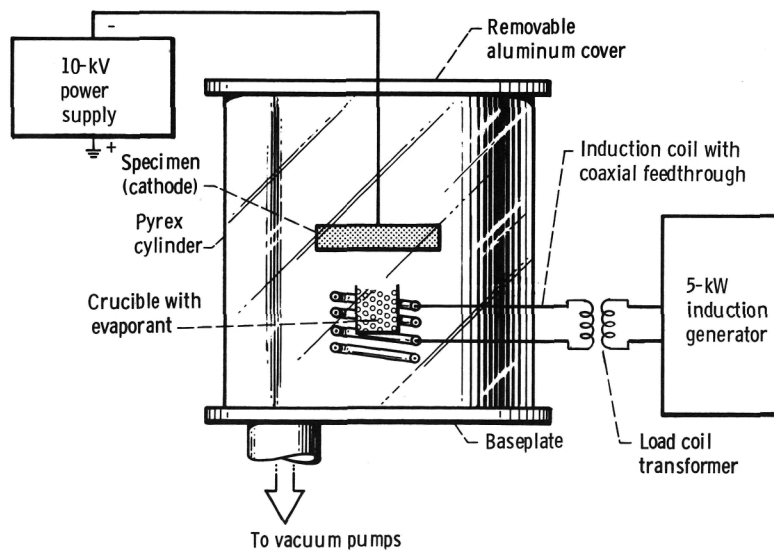
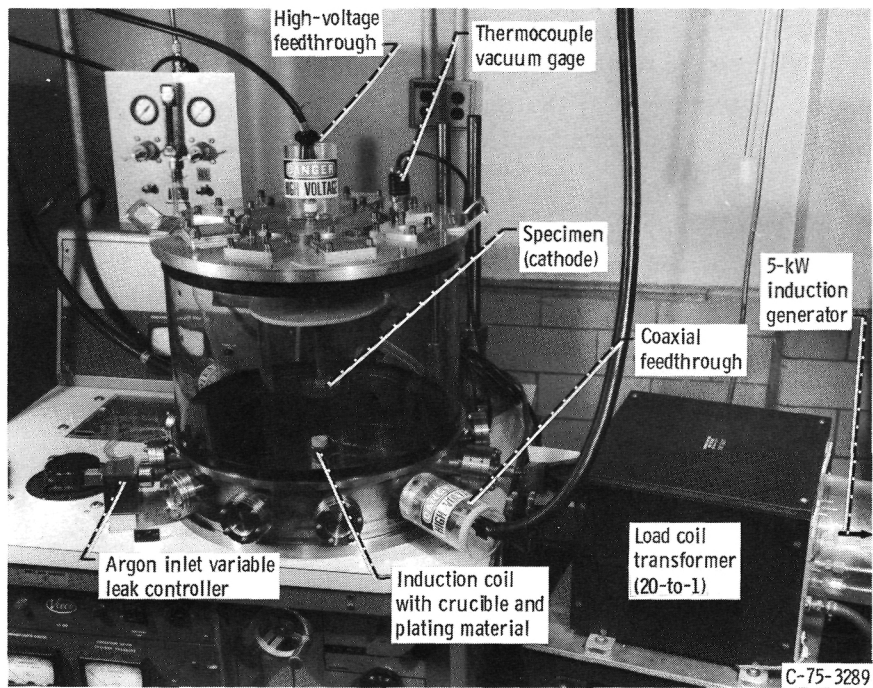


Figure 1. - Ion plating with induction heating source.



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